

FRP BOAT BUILDING TERMS

Fibreglass boats? You mean Tupperware boats.

Anonymous

By Jeffrey Casciani-Wood

<i>Accelerator</i>	means an additive given to polyester resin to speed the curing at workshop temperature. The marine surveyor must take care not to mix an accelerator with the catalyst as an explosive reaction may take place..
<i>Activated Resin</i>	means a resin with a catalyst added.
<i>Additive</i>	means any substance added to another substance, usually to improve properties, such as plasticisers, initiators, light stabilizers and flame retardants. See <i>Filler</i> .
<i>Adherend</i>	means a body that is held to another body, usually by an adhesive. A detail or part prepared for bonding.
<i>Adhesion</i>	means the state in which two surfaces are held together at an interface by mechanical or chemical forces or interlocking action or both.
<i>Adhesion Promoter</i>	A coating applied to a substrate before it is coated with an adhesive, to improve the adhesion of the plastic. Also called a primer.
<i>Adhesive</i>	A substance capable of holding two materials together by surface attachment. Adhesive may be in film, liquid or paste form.
<i>Adhesive Failure</i>	Rupture of an adhesive bond such that the separation appears to be at the adhesive-adherent interface.
<i>Adhesive Film</i>	A synthetic resin adhesive, with or without a film carrier fabric, usually of the thermosetting type, in the form of a thin film of resin, used under heat and pressure as an interleaf in the production of bonded structures.
<i>Adhesive Joint</i>	The location at which two adherends or substrates are held together with a layer of adhesive. The general area of contact for a bonded structure.
<i>Adhesive Strength</i>	Strength of the bond between an adhesive and an adherend.
<i>Air Bubble Void</i>	Air entrapment within and between the plies of reinforcement or within a bond line or encapsulated area; localized, non-interconnected and spherical in shape.
<i>Areal Weight</i>	The weight of fibre per unit area (width x length) of tape or fabric.
<i>Assembly Time</i>	The time interval between the spreading of the adhesive on the adherend and the application of pressure and/or heat to the assembly.
<i>Aramid</i>	Aromatic polyamide fibres characterized by excellent high temperature, flame resistance and electrical properties.
<i>Amine Blush</i>	Most epoxy resins used in boatbuilding have amine based hardeners and, after the epoxy, has cured there will usually be a noticeable oily residue

on the surface called amine blush. The amount of amine blush can vary considerably from almost unnoticeable to very oily, the difference being the result of variations in temperature and humidity.

<i>A-Stage</i>	An early stage in the reaction of a thermosetting resin in which the material is still soluble and fusible.
<i>Autoclave</i>	A closed vessel for producing an environment of fluid pressure, with or without heat, to an enclosed object while undergoing a chemical reaction or other operation.
<i>Bagging</i>	Applying an impermeable layer of film over an uncured part and sealing the edges so that a vacuum can be drawn.
<i>Bag Moulding</i>	A process in which the consolidation of the material in the mould is effected by the application of fluid or gas pressure through a flexible membrane.
<i>Bag Side</i>	The side of the part that is cured against the vacuum bag.
<i>Balanced Construction</i>	Equal parts of warp and fill in fibre fabric. Construction in which reactions to tension and compression loads result in extension or compression deformations only and in which flexural loads produce pure bending of equal magnitude in axial and lateral directions.
<i>Balanced Laminate</i>	A composite laminate in which all laminate at angles other than 0 and 90 degrees occur only in \pm pairs (not necessarily adjacent) and are symmetrical around the centreline.
<i>Balsa Sandwich</i>	End grain balsa wood used as a core material between frp laminates.
<i>Barcol Hardness</i>	A hardness value obtained by measuring the resistance to penetration of a sharp steel point under a spring load. The instrument, called the Barcol impressor, gives a direct reading on a 0 to 100 scale. The hardness value is often used as an approximate measure of the degree of cure of a plastic.
<i>Barrier Coat</i>	A protective outer coating applied to the bottom of an frp vessel to reduce the ingress of water into the bottom laminate. Typically an epoxy or a vinylester resin, the barrier coat can be applied over an existing gel coat as a preventative measure or as a replacement after removal of a damaged gel coat and laminate.
<i>Batch</i>	In general, a quantity of material formed during the same process or in one continuous process and having identical characteristics throughout. Also called a lot.
<i>Bias Fabric</i>	A fabric in which warp and fill fibres are at an angle to the length.
<i>Binder</i>	The resin or cementing constituent (of a plastic compound) that holds the other components together. The agent applied to fibre mat or pre-forms to bond the fibres before laminating or moulding.
<i>Bladder</i>	An elastomeric lining for the containment of hydroproof or hydroburst pressurization medium in filament-wound structures.

<i>Bleeder Cloth</i>	A non structural layer of material used in the manufacture of composite parts to allow the escape of excess gas and resin during cure. The bleeder cloth is removed after the curing process is complete and is not part of the final composite.
<i>Bleed-out</i>	The excess liquid resin appearing at the surface primarily occurring during filament winding.
<i>Blisters</i>	Blisters may appear on the gel coat surface of boats constructed of frp and may or may not be osmotic in origin. There are seven types of blister ranging from merely cosmetic to structurally dangerous in severity. See <i>Gel Coat</i> , <i>Osmosis</i> and <i>Wicking</i> .
<i>Bond Strength</i>	The amount of adhesion between bonded surfaces. The stress required to separate a layer of material from the base to which it is bonded, as measured by load/bond area. See also <i>Peel Strength</i> .
<i>Bonding Angles</i>	An additional frp laminate or extension thereof used to make up a joined member that attaches to an existing laminate and is used to attach such items as stiffeners, frames, bulkheads, shelves to the shell or to each other.
<i>Breather</i>	A loosely woven material, such as glass fabric, which serves as a continuous vacuum path over a part but does not come in contact with the resin. The breather is removed after the curing process is complete and is not part of the final composite.
<i>Bridging</i>	Condition in which the fibres do not move into or conform to radii and corners during moulding, resulting in voids and dimensional control problems.
<i>Broad Goods</i>	Fibre woven to form fabric up to 1270 mm (50 in.) wide. It may or may not be impregnated with resin and is usually furnished in rolls of 25 to 140 kg. (50 to 300 lb.).
<i>B-Stage</i>	An intermediate stage in the reaction of a thermosetting resin in which the material melts when heated and dissolves in certain solvents. Materials are usually pre-cured to this stage to facilitate handling and processing prior to final cure.
<i>Bulk Factor</i>	The ratio of the volume of a raw moulding compound or powdered plastic to the volume of the finished solid piece produced there from. The ratio of the density of the solid plastic object to the apparent or bulk density of the loose moulding powder.
<i>Bulk Moulding Compound (BMC)</i>	Thermosetting resin mixed with strand reinforcement, fillers, and so on, into a viscous compound for compression or injection moulding. See also <i>Sheet Moulding Compound</i> .
<i>Capacitance</i>	The ability of a given substance to hold a quantity of electric charge.

<i>Carbon Fibres</i>	Fibres produced from pyrolytic degradation of synthetic organic fibres, polyacrylonitrile (PAN) or rayon, which contain about 92-99% carbon content and typically have modulus values up to 75×10^6 p.s.i
<i>Catalyst</i>	A substance additive given to the resin that changes the rate of a chemical reaction without itself undergoing permanent change in composition or becoming a part of the molecular structure of the product. A substance that markedly speeds up the cure of a compound when added in minor quantity as compared to the amounts of primary reactants and induces curing with heat or with an accelerator at workshop temperature.
<i>Chemical Bond</i>	A bond formed by the chemical cross linking of a resin polymer during its curing period. A primary bond between laminates is a chemical bond and a secondary bond is an adhesive bond to an already cured laminate where the resin has cured to such a degree that polymer cross linking is no longer possible when the next laminate is applied.
<i>Caul Plates</i>	Smooth metal, plastic, or rubber plates free of surface defects. A caul plate must be the appropriate size and shape for the composite lay-up with which it will be used. It is used in immediate contact with the lay-up during the curing process to transmit normal pressure and provide a smooth surface on the finished part.
<i>Cavity</i>	The space inside a mould in which a resin or moulding compound is poured or injected. The female portion of a mould. That portion of the mould that encloses the moulded article (often referred to as the die). Depending on the number of such depressions, moulds are designated as single or multiple cavity.
<i>Cell</i>	In honeycomb core, a cell is a single honeycomb unit usually in a hexagonal shape.
<i>Chopped Strand Mat</i>	Fibre reinforcement material of short randomly oriented fibres to achieve strength in all directions as a laminate as opposed to <i>Woven Rovings (q.v.)</i> , knitted or unidirectional fabrics which achieve maximum strength in discrete directions within a laminate.
<i>Colour Pigment</i>	means a colourant added to give colour to the gel coat resin.
<i>Co-cured</i>	Cured and simultaneously bonded to another prepared surface.
<i>Coefficient of Thermal Expansion</i>	The fractional change in length of a material for each unit change in temperature.
<i>Cohesion</i>	The propensity of a single substance to adhere to itself. The internal attraction of molecular particles toward each other. The ability to resist partition of itself. The force holding a single substance together.
<i>Cohesive Failure</i>	Failure of an adhesive joint occurring primarily in an adhesive layer.
<i>Coin Tap Test</i>	Using a coin to tap a laminate in different spots, listening for a change in sound, which would indicate the presence of a defect. A surprisingly accurate test in the hands of an experienced marine surveyor.

<i>Compaction</i>	The application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up.
<i>Composite</i>	A material created from a fibre (or reinforcement) and an appropriate matrix material in order to maximize specific performance properties. The constituents do not dissolve or merge completely but retain their identities as they act in concert.
<i>Compression Moulding</i>	A technique for moulding thermoset plastics in which a part is shaped by placing the fibre and resin into an open mould cavity, closing the mould, and applying heat and pressure until the material has cured or achieved its final form.
<i>Compressive Modulus</i>	The ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile experiments.
<i>Compressive Strength</i>	A material's ability to resist a force that tends to crush or buckle. The maximum compressive load a specimen sustains divided by the specimen's original cross-sectional area.
<i>Conditioning</i>	Subjecting a material to a prescribed environmental and/or stress history before testing.
<i>Contact Moulding</i>	A moulding technique in which reinforcement and resin are placed in a mould, with cure taking place at room temperature with a catalyst/promoter system or in a heated oven. No additional pressure is used.
<i>Core</i>	In fibreglass construction, a layer between fibreglass skins, made of foam, end grain balsa or other strengthening material to increase the stiffness of the deck. Also, part of a complex mould that forms undercut parts.
<i>Core Crush</i>	A collapse, distortion or compression of the core.
<i>Cored FRP</i>	See <i>Sandwich Construction</i> .
<i>Count</i>	For fabric, number of warp and filling yarns per inch in woven cloth and, for yarn, size based on relation of length and weight.
<i>Coupon</i>	Usually, a specimen for a specific test, as a tensile coupon.
<i>Creep</i>	The dimensional change in a material under physical load over time beyond instantaneous elastic deformation.
<i>Cross Laminated</i>	Material laminated so that some of the layers are oriented at various angles to the other with respect to the laminate grain. A cross ply laminate usually has plies oriented only at 0 and 90 degrees.
<i>Cross Linking</i>	Applied to polymer molecules, the setting-up of chemical links between the molecular chains. When extensive, as in most thermosetting resins, cross-linking makes one infusible super-molecule of all the chains.

<i>C-Stage</i>	The final stage of the curing of a thermosetting resin in which the material has become infusible and insoluble in common solvents.
<i>Cure</i>	To change the properties of a thermosetting resin irreversibly by chemical reaction, i.e., condensation, ring closure, or addition. Cure may be accomplished by addition of curing (cross-linking) agents, with or without catalyst, and with or without heat.
<i>Cure Cycle</i>	The time/temperature/pressure cycle used to cure a thermosetting resin system of <i>Prepreg</i> (q.v.).
<i>Cure Stress</i>	A residual internal stress produced during the curing cycle of composite structures. Normally, these stresses originate when different components of a wet lay-up have different thermal coefficients of expansion.
<i>Curing Agent</i>	A catalytic or reactive agent that brings about polymerisation when it is added to a resin.
<i>Debond (Noun)</i>	Separation of a bonded joint or a debonded or non adhered region; a separation at the fibre-matrix interface due to strain incompatibility.
<i>Debond, to (Verb)</i>	A deliberate separation of a bonded joint or interface, usually for repair or reworking purposes. In the United Kingdom, the term also often refers to accidental damage. See also <i>delamination</i> . Also called in America disbonding.
<i>Debulking</i>	Compacting of a thick laminate under moderate heat and pressure and/or vacuum to remove most of the air, to ensue seating on the tool and to prevent wrinkles.
<i>Deflashing</i>	The process of removal of flash or rind left on plastic mouldings by spaces between mould cavity edges. Methods include tumbling or blast finishing or both, use of dry or wet abrasive belts and hand methods using knives, scrapers, broaching tools and files. Soft thermoplastic parts are sometimes deflashed by the cryogenic method, in which the parts are tumbled while chilled by a coolant such as liquid nitrogen.
<i>Delamination</i>	The separation of a laminated plastic material along the plane of its layers.
<i>Denier</i>	A numbering system for yarn and filament in which yarn number is equal to weight in grams of 9000 meters of yarn.
<i>Draft Angle</i>	The angle of a taper on a mandrel or mould that facilitates removal of the finished part.
<i>Drape</i>	The ability of a fabric or <i>Prepreg</i> (q.v.) to conform to a contoured surface.
<i>Dry Laminate</i>	A laminate containing insufficient resin for complete bonding of the reinforcements. See also <i>Resin Starved</i> .

<i>Dry Lay-Up</i>	Construction of a laminate by the layering of preimpregnated reinforcement (partly cured resin) in a female mould or on a male mould, usually followed by bag moulding or autoclave moulding.
<i>E-Glass</i>	Electrical glass; the borosilicate glass most often used for the glass fibres in conventional reinforced plastics. See <i>S-Glass</i> .
<i>Encapsulated</i>	A frame or floor or section of ballast covered over with an frp matrix such that it is hidden from sight is said to be encapsulated. The term may also apply to the nuts of keel or stem bolts.
<i>End</i>	A strand of roving consisting of a given number of filaments gathered together. The group of filaments is considered an end or strand before twisting, a yarn after twist has been applied. An individual warp yarn, thread, fibre or roving.
<i>Epoxy</i>	A form of resin based on coal tar. A polymerisable thermoset polymer containing one or more epoxide groups and curable by reaction with amines, alcohols, phenols, carboxylic acids, acid anhydrides and mercaptans. An important matrix resin in composites and structural adhesive. It has very high physical properties and corrosion resistance. It also has the highest water proof characteristics but is difficult and expensive to use and only marginally tolerant of polyester resins especially polyester laminates that have been damaged by hydrolysis. Vessels built entirely of epoxy resin do not generally blister but are very expensive.
<i>Exotherm</i>	The liberation or evolution of heat during the curing of a plastic product.
<i>Fibre Content</i>	The amount of fibre present in a composite. This is usually expressed as a percentage volume fraction or weight fraction of the composite.
<i>Fibre Count</i>	The number of fibres per unit width of ply present in a specified section of a composite.
<i>Fibre Direction</i>	The orientation or alignment of the longitudinal axis of the fibre with respect to a stated reference axis.
<i>Fibre Orientation</i>	The fibre alignment in a non woven or a mat laminate in which most of the fibres are in the same direction, thereby affording higher strength in that direction.
<i>Fibre Reinforced Plastic (FRP)</i>	A general term for a resin composite that is reinforced with cloth, mat, strands or any other fibre form.
<i>Fire Resistant Additive</i>	means antimony trioxide and chlorinated organic compound mixed with resin or any other manufacturer approved additive.
<i>Filament</i>	The smallest unit of a fibrous material. The basic units formed during drawing and spinning, which are gathered into strands of fibre/fibre for use in composites. Filaments usually are of extreme length and very small diameter, usually less than 25 fm (1 mil). Normally filaments are not used individually. Some textile filaments can function as yarn when they are of sufficient strength and flexibility.

<i>Filament Winding</i>	A process for fabricating a composite structure in which continuous reinforcements (filament, wire, yarn, tape or other), either previously impregnated with a matrix material or impregnated during the winding, are placed over a rotating and removable form or mandrel in a prescribed way to meet certain stress conditions. Generally the shape is a surface of revolution and may or may not include end closures. When the required number of layers is applied, the wound form is cured and the mandrel removed.
<i>Fill</i>	The American name for the <i>Weft</i> (q.v.).
<i>Filler</i>	A relatively inert pasty substance added to a material to alter its physical, mechanical, thermal, electrical and other properties or to lower cost or density. Sometimes the term is used specifically to mean particulate additives.
<i>Film Adhesive</i>	An adhesive in the form of a thin, dry, resin film with or without a carrier, commonly used for adhesion between layers of laminates.
<i>Finish</i>	Material applied to fibre/fibres, after sizing is removed, to improve matrix to fibre/fibre coupling.
<i>Flash</i>	Excess material which forms at the parting line of a mould or die or which is extruded from a closed mould.
<i>Flexural Modulus</i>	The ratio, within the elastic limit, of the applied stress on a test specimen in flexure to the corresponding strain in the outermost fibre/fibres of the specimen.
<i>Foam</i>	means closed cell polyurethane or rigid PVC foam.
<i>Former</i>	means material used for the purpose of forming, reinforcing and stiffening members.
<i>Fracture</i>	A rupture of the surface of a laminate because of external or internal forces, with or without complete separation.
<i>FRP</i>	Fibre reinforced plastic. See <i>GRP</i> .
<i>Ganged Woven Rovings</i>	An frp laminate consisting of adjacent layers of woven rovings without the normally applied layer of chopped strand mat between layers.
<i>Gel</i>	The initial jellylike solid phase that develops during the formation of a resin from a liquid. A semisolid system consisting of a network of solid aggregates in which liquid is held.
<i>Gel Coat</i>	The outer cosmetic quick setting resin skin of an frp vessel applied to the female mould prior to the matrix lay-up process. It is a semithixotropic, air inhibited, solid, hard, pigmented polyester resin and is used on the majority of fibreglass boats as the protective outer coating on the bottom, sides and deck. The gel coat becomes an integral part of the finished laminate, and is usually used to improve surface appearance and bonding. A usually pigmented resin that is applied to a waxed mould surface over which subsequent fibreglass lay-up is made. When the

piece is removed from the mould, the gel coat becomes the outside finish. It works well on the sides and deck but is not usually waterproof enough on the bottom to prevent water absorption and subsequent hydrolysis. See *Blisters*, *Osmosis* and *Wicking*.

<i>Gel Time</i>	means the period from addition of the accelerator to the setting of the resin to a soft gel under specified conditions of temperature as measured by a specific test.
<i>Gelation</i>	means the curing process of the resin liquid to a jelly like state.
<i>Glass Cloth</i>	Conventionally woven glass fibre/fibre material; certain lightweight glass fabrics are also called scrims.
<i>Glass Reinforcement</i>	means fabric, chopped strand mat (CSM), woven rovings (WR) or combination materials stitched together and used in the lay-up for reinforcement of the laminate.
<i>Glass Tabbings</i>	<i>Bonding Angles. (q.v.)</i>
<i>Glass Transition Temperature (Tg)</i>	The approximate midpoint of the temperature range over which the glass transition takes place. Glass and silica fibre/fibre exhibit a phase change at approximately 955 C (1750 F) and carbon/graphite fibre/fibres at 2205 to 2760 C (4000 to 5000 F). The temperature at which increased molecular mobility results in significant changes in the properties of a cured resin system. Also, the inflection point on a plot of modulus versus temperature. The measured value of Tg depends to some extent on the method of test.
<i>Graphite Fibres</i>	A group of carbon fibre/fibres which have a carbon content of about 99% and also have high modulus values. This term is used interchangeably with carbon fibre/fibres throughout the industry.
<i>Glycol</i>	A generic term and covers the alcohol constituent of a resin.
<i>Green Stage</i>	means in a soft rubbery state.
<i>GRP</i>	Glass reinforced resin plastic. Often called fibreglass. See <i>Fibre Reinforced Plastic</i> .
<i>Hand Lay-up</i>	A fabrication method in which reinforcement layers, pre-impregnated or coated afterwards, are placed in a mould by hand and then cured to the formed shape.
<i>Hardener</i>	A substance used to promote or control curing action by taking part in it; as opposed to catalyst.
<i>Hardening Time</i>	means the time from the setting of the resin to a point when the resin is hard enough for removal from the mould.
<i>Heat Distortion Point</i>	The temperature at which a standard test bar deflects a specified amount under a stated load. Now called <i>Deflection Temperature</i> .
<i>Heat Resistance</i>	The property or ability of plastics and elastomers to resist the deteriorating effects of elevated temperatures.

<i>Heat Sink</i>	A contrivance for the absorption or transfer of heat away from a critical element or part. Bulk graphite is often used as a heat sink.
<i>Hinging</i>	This is the term applied to a defect in an frp boat whereby, due to changes in water pressure as the boat is moving, the panels forming the sides of the boat move round a hard spot in the structure such as the ill fitted edge of a bulkhead treating it as a hinge. The defect shows up as long gel coat cracks following down the line of the bulkhead. The defect can also be found in the edges of decks and in cockpit seats.
<i>Honeycomb</i>	Resin impregnated material manufactured in, usually, hexagonal cells that serves as a core material in sandwich constructions. Honeycomb may also be metallic or polymer materials in a rigid, open cell structure.
<i>Hull Liner</i>	A separate interior hull unit constructed of frp and often fitted with bunks, berths, bulkheads and other parts of the outfit including the <i>Cabin Sole (q.v.)</i> and inserted into and bonded to the shell. A hull liner can contribute varying degrees of strength and stiffness to the hull depending upon the arrangements of the bunks and bulkheads <i>etc.</i>
<i>Hybrid</i>	A composite laminate comprised of laminae of two or more composite material systems, e.g., graphite and glass. It also applies to woven fabrics having more than one type of fibre/fibre.
<i>Hydrolysis</i>	A chemical process of decomposition involving splitting of an electron bond and addition of the elements of water. When used in reference to the polyester bottom blister problem, the bond being broken is the ester linking molecule between the phthalic acid and the alcohol in the polyester compound.
<i>Impregnate</i>	To saturate the voids and interstices of a reinforcement with a resin.
<i>Injection Moulding</i>	Method of forming a plastic to the desired shape by forcing the heat softened plastic into a relatively cool cavity under pressure.
<i>Inner Moulding</i>	A light moulding consisting of a fibre reinforced matrix and gel coat fitted inside the hull of an frp boat to form the basis of the interior outfit. See <i>Hull Liner</i> .
<i>Interface</i>	The boundary or surface between two different, physically distinguishable media. On fibre/fibres, the contact area between fibre/fibres and sizing or finish. In a laminate, the contact area between the reinforcement and the laminating resin.
<i>Interlaminar</i>	Existing or occurring between two or more adjacent laminae.
<i>Interlaminar Shear</i>	A shearing force tending to produce a relative displacement between two laminae along the plane of their interface.
<i>Intumescent Paint</i>	means a resin paint which has resistance to a direct flame by creating a carbonaceous foam from which the inert gases thereby formed insulate the main structure of the laminate.

<i>Isophthalic Acid</i>	A phthalic acid. A high grade of polyester resin is based on isophthalic acid. Though it is less soluble than orthophthalic based resin, it still hydrolyses and blisters as much. It is more expensive and somewhat harder to work with than Orthophthalic Resin.
<i>Kevlar</i>	Registered trademark of E.I. DuPont de Nemours Inc. For a strong organic fibre/fibre similar to fibre/fibreglass but having a higher strength to weight ratio. When woven into cloth and impregnated with a thermosetting epoxy resin, it produces a material having high impact resistance and low radio frequency attenuation. Generic term: aramid.
<i>Kissing Bond</i>	A dry are between fibre reinforcements with a laminate matrix where the reinforcement layers touch or kiss but are not bonded together by resin.
<i>Knitted Fabrics</i>	Fibre reinforcements arranged in layers and then knitted together with lighter fibres to maintain shape during lamination. They may be arranged in various orientations to achieve high strength in a given desired directions.
<i>Laminate</i>	To manufacture a Laminate by successive layers of fibre reinforcement impregnated with resin by hand forming a moulding. Also called a <i>Matrix</i> . The laminate is to be distinguished from the gel coat or core material of an frp vessel and the word is used in one of two forms: - <ul style="list-style-type: none"> i. (Verb): To build up a solid sheet of material by successive layers of fibreglass mat or cloth and resin. ii. (Noun): The resulting final product of laminating fibreglass cloth and resin.
<i>Laminate Orientation</i>	The configuration of a cross plied composite laminate with regard to the angles of cross plying, the number of laminae at each angle, and the exact sequence of the lamina lay-up.
<i>Laminate Spray</i>	means the application of the resin and glass reinforcement forming the matrix by a mechanical spray method.
<i>Lay-up</i>	The reinforcing material placed in position in the mould. The process of placing the reinforcing material in position in the mould. The resin impregnated reinforcement. A description of the component materials, geometry and so forth of a laminate.
<i>Lot</i>	A specific amount of material produced at one time using the same process and the same conditions of manufacture, and offered for sale as a unit quantity.
<i>Mandrel</i>	The core tool around which resin-impregnated paper, fabric or fibre/fibre is wound to form pipes, tubes or structural shell shapes.
<i>Mat</i>	A fibrous reinforcing material comprised of chopped filaments (for chopped strand mat) or swirled filaments (for continuous strand mat) with a binder to maintain form; available in blankets of various widths, weights and lengths.

<i>Matrix</i>	The solid main structure of the hull of an frp boat inside the gel coat and built from glass or layers of fibre mats wetted out with various resins. See <i>Laminate</i> . Also material in which the fibre/fibre of a composite is imbedded. It may be plastic, metal, ceramic or glass.
<i>Mil</i>	The unit used in measuring the diameter of glass fibre/fibre strands, wire <i>etc.</i> (1 mil = 0.001 in.).
<i>Milled Fibre</i>	Continuous glass strands hammer milled into very short glass fibre/fibres. Useful as inexpensive filler or anticrazing reinforcing fillers for adhesives.
<i>Moisture Content</i>	The amount of moisture in a material determined under prescribed conditions and expressed as a percentage of the mass of the moist specimen, that is, the mass of the dry substance plus the moisture present.
<i>Mould</i>	The cavity or matrix into or on which the plastic composition is placed and from which it takes form. To shape plastic parts or finished articles by heat and pressure. The assembly of all the parts that function collectively in the melding process.
<i>Moulding</i>	The forming of a polymer or composite into a solid mass of prescribed shape and size by the application of pressure and heat for given times. Sometimes used to denote the finished part.
<i>Moulding Pressure</i>	The pressure applied to the ram of an injection machine or compression or transfer press to force the softened plastic to fill the mould cavities completely.
<i>Mould Release Agent</i>	A lubricant, liquid, or powder used to prevent sticking of melded articles in the cavity.
<i>Mould Surface</i>	The side of a laminate that faced the mould (tool) during cure in an autoclave or hydroclave.
<i>Orange Peel</i>	An uneven surface somewhat resembling that of an orange peel and said of injection mouldings that have unintentionally ragged surfaces.
<i>Orthophthalic Acid</i>	A phthalic acid. See <i>Isophthalic acid</i> .
<i>Osmosis</i>	A natural process of diffusion through a semi permeable membrane separating a solvent and a solution that tends to equalize their concentration. It is believed to be one of the processes by which water is drawn into the laminate. The membrane is the gel coat, the solvent is water and the solution is the acidic or alkaline solution that forms when water and the water soluble elements in the laminate resin are combined. The process of osmosis is probably one of the reasons why the small concentration of hydrolysed solution grows into a blister. See <i>Blisters</i> , <i>Gel Coat</i> and <i>Wicking</i> . Often, incorrectly, used by the ignorant to describe the blisters themselves.
<i>Out Time</i>	The time a <i>Prepreg</i> (<i>q.v.</i>) is exposed to ambient temperature, namely, the total amount of time the <i>Prepreg</i> is out of the freezer. The primary

effects of our time are to decrease the drape and tack of the prepreg while also allowing it to absorb moisture from the air.

<i>Parting Line</i>	A mark on a melded piece where the sections of a mould have met in closing.
<i>Peel Ply</i>	A layer of woven a prepreg lay-up cloth surface partially retted with resin and then applied to the surface of a curing laminate as a surface preparation for a later laminate application. The cloth is peeled off just prior to applying the next layer to present a clean, wax free, resin-rich surface for the next layer ready for bonding.
<i>Peel Strength</i>	Adhesive bond strength, as in pounds per inch of width, obtained by stress applied in a peeling mode.
<i>pH</i>	The measure of the acidity or alkalinity of a substance, neutrality being at pH 7, acid solutions are less than 7, alkaline solutions are more than 7.
<i>Plain Weave</i>	A weaving pattern in which the warp and fill fibre/fibres alternate, <i>i.e.</i> , the repeat pattern is warp/weft/warp/weft and so on. Both faces of a plain weave are identical. Properties are significantly reduced relative to a weaving pattern with fewer crossovers.
<i>Platens</i>	The mounting plates of a press to which the entire mould assembly is bolted.
<i>Plexus</i>	A term borrowed from the medical profession and used as a name for the longitudinal and transverse primary bottom supporting structural framework in fibre reinforced plastic boats. Also sometimes called a matrix.
<i>Plug</i>	The name for the hollow female mould from which an frp hull is first moulded.
<i>Ply</i>	In general, fabrics or felts consisting of one or more layers that make up a stack. Yarn resulting from twisting operations or a single layer of <i>Prepreg (q.v.)</i> . Also a single pass in filament winding.
<i>Polymer</i>	A very large molecule formed by combining a large number of smaller molecules, called monomers, in a regular pattern.
<i>Polymerization</i>	A chemical reaction in which the molecules of monomers are linked together to form polymers.
<i>Post Cure</i>	The exposure of certain resins to higher than normal curing temperatures after the initial cure cycle. This second stage is necessary to attain the complete cure and desired mechanical properties of the resins involved. The higher temperatures are used separately because they would result in an excessive reaction if applied throughout the entire cure.
<i>Pot Life</i>	The length of time a catalysed thermosetting resin system retains a viscosity low enough for it to be suitable for processing.
<i>Powder Bonded Mat</i>	means a glass fibre reinforcement material impregnated with high solubility polyester powder.

<i>Preform</i>	A pre-shaped fibrous reinforcement formed by distribution of chopped fibre/fibres or cloth by air, water flotation or vacuum over the surface of a perforated screen to the approximate contour and thickness desired in the finished part. Also, a pre-shaped fibrous reinforcement of mat or cloth formed to the desired shape on a mandrel or mock up before being placed in a mould press.
<i>Prepreg or Preimpregnated</i>	A combination of mat, fabric, nonwoven material, or roving with resin, usually advanced to the B-Stage (<i>q.v.</i>), ready for curing.
<i>Pressure Bag Moulding</i>	A process for moulding reinforced plastics in which a tailored, flexible bag is placed over the contact lay up on the mould, sealed and clamped in place. Fluid pressure, usually provided by compressed air or water, is placed against the bag and the part is cured.
<i>Pressure Intensifier</i>	A layer of flexible material (usually a high-temperature rubber) used to ensure the application of sufficient pressure to a location, such as a radius, in a lay-up, being cured.
<i>Primer</i>	A coating applied to a surface before the application of an adhesive, lacquer, enamel <i>etc.</i> , to improve the adhesion performance or load carrying ability of the bond.
<i>Print Through</i>	See Skin Out layer.
<i>Processing Window</i>	The range of processing conditions, such as stock (melt) temperature, pressure, shear rate <i>etc.</i> , within which a particular grade of plastic can be fabricated with optimum or acceptable properties by a particular fabricating process.
<i>Prototype</i>	A model suitable for use in complete evaluation of form, design, performance, and material processing.
<i>Primary Bond</i>	See <i>Chemical Bond</i> .
<i>Pre-accelerated Resin</i>	means a resin to which an accelerator has been previously added.
<i>Resin Infusion</i>	A method of laminating a hull whereby resin is forced under pressure into the dry matrix material resulting in lower emissions and a better glass/resin ratio.
<i>Polyester</i>	A form of resin based on a phthalic acid and a glycol commonly used in fibreglass construction. Most modern boats are built with resins based on isophthalic acids.
<i>Reinforcement</i>	A material added to the matrix to provide the required properties; ranges from short fibre/fibres through complex textile forms.
<i>Release Agents</i>	Materials that are used to prevent cured matrix material from bonding to tooling.
<i>Release Film</i>	An impermeable layer of film that does not bond to the resin being cured. See also <i>Separator</i> .

<i>Resin</i>	A generic name for any plastic an unsaturated polyester synthetic material that starts out as a liquid and becomes solid through a curing process. A material, generally a polymer, that has an indefinite and often high molecular weight and a softening or melting range and exhibits a tendency to flow when it is subjected to stress. Epoxies, polyesters and vinylesters are all resins. Resins are, simply, a product of the chemical reaction between an acid and an alcohol. Resins are used as the matrices to bind together the reinforcement material in composites.
<i>Resin Content</i>	The amount of resin in a laminate expressed as either a percentage of total weight or total volume.
<i>Resin Rich</i>	Localized area filled with resin but lacking reinforcement fibre/fibre.
<i>Resin Starved</i>	Localized area lacking sufficient resin for wet out of the fibre/fibres.
<i>Resin Transfer Moulding (RTM)</i>	A moulding process in which catalysed resin is transferred into an enclosed mould into which the fibre/fibre reinforcement has been placed. Cure normally is accomplished without external heat. RTM combines relatively low tooling and equipment costs with the ability to mould large structural parts.
<i>Rovings</i>	A number of yarns, strands, tows or ends collected into a parallel bundle with little or no twist.
<i>RT</i>	Stands for ambient room temperature, usually between 21-25°C (70-77°F).
<i>Sandwich Construction</i>	Describes a form of construction where two relatively strong and dense relatively thin layers of fibreglass are held apart by a light weight core material, often of honeycomb, foamed plastic or Balsawood, bonded to the inner and outer skins (also called faces) to increase panel stiffness, carry shear loads and to reduce weight.
<i>Scrim</i>	A low cost reinforcing fabric made from continuous filament yarn in an open-mesh construction. Used in the processing of tape or other B-Stage (<i>q.v.</i>) material to facilitate handling. Also used as a carrier of adhesive, to be used in secondary bonding.
<i>Secondary Bond</i>	The joining together, by the process of adhesive bonding, of two or more already cured composite parts, during which the only chemical or thermal reaction occurring is the curing of the adhesive itself. See <i>Chemical Bond</i> .
<i>Separator</i>	A permeable layer that also acts as a release film. Porous Teflon coated fibre/fibreglass is an example. Often placed between layup and bleeder to facilitate bleeder system removal from laminate after cure.
<i>Set Up</i>	To harden, as in curing of a polymer resin.
<i>S-Glass</i>	Structural glass; a magnesia/alumina/silicate glass reinforcement designed to provide very high tensile strength. See <i>E-Glass</i> .

<i>Sheet Moulding Compound (SMC)</i>	A composite of fibre/fibres, usually a polyester resin and pigments, fillers and other additives that have been compounded and processed into sheet form to facilitate handling in the moulding operation.
<i>Shelf Life</i>	The length of time a material, substance, product or reagent can be stored under specified environmental conditions and continue to meet all applicable specification requirements and/or remain suitable for its intended function. Also called Storage Life.
<i>Shrinkage</i>	The relative change in dimension from the length measured on the mould when it is cold to the length of the melded object 24 hrs after it has been taken out of the mould.
<i>Size</i>	Any treatment consisting of starch, gelatin, oil, wax or other suitable ingredient applied to yarn or fibre/fibres at the time of formation to protect the surface and aid the process of handling and fabrication or to control the fibre/fibre characteristics. The treatment contains ingredients that provide surface lubricity and binding action but, unlike a finish, contains no coupling agent. Before final fabrication into a composite, the size is usually removed by heat cleaning and a finish is applied.
<i>Sizing Content</i>	The percent of the total strand weight made up by the sizing; usually determined by burning off or dissolving the organic sizing; known as loss on ignition.
<i>Skin</i>	A layer of relatively dense material used in a sandwich construction of the surface of the core.
<i>Skin Coat</i>	A special layer of resin reinforced with a layer of mat or light cloth under the gel coat to prevent blistering.
<i>Skin Out Layer</i>	Also Skin Out Mat. A term for the first layer of chopped strand mat laid inside the gel coat when the boat is being built to prevent the coarser weave pattern of heavier fibreglass cloth in the matrix from telegraphing its presence through to the finished surface – a phenomenon called Print Through.
<i>Spray Up</i>	A technique in which a spray gun is used as an applicator tool. In reinforced plastics, for example, fibrous glass and resin can be simultaneously deposited in a mould. In essence, roving is fed through a chopper and ejected into a resin stream that is directed at the mould by either of two spray systems. In foamed plastics, fast reacting urethane foams or epoxy foams are fed in liquid streams to the gun and sprayed on the surface. On contact, the liquid starts to foam.
<i>Stacking Sequence</i>	A description of a laminate that details the ply orientation and their sequence in the laminate.
<i>Star Crazeing</i>	A pattern of fine cracks in the gel coat usually radiating from a point and as a result of a local high stress or damage.

<i>Stops</i>	Metal pieces inserted between die halves. Used to control the thickness of a press moulded part. Not a recommended practice, because the resin will receive less pressure, which can result in voids.
<i>Strand</i>	Normally an untwisted bundle or assembly of continuous filaments used as a unit, including slivers, tows, ends, yarn, <i>etc.</i> Sometimes a single fibre/fibre or filament is called a strand.
<i>Structural Adhesive</i>	Adhesive used for transferring required loads between adherends exposed to service environments typical for the structure involved.
<i>Structural Bond</i>	A bond that joins basic load-bearing parts of an assembly. The load may be either static or dynamic.
<i>Styrene</i>	A chemical used in the manufacture of resin and which polymerises (links) the polyester chains into a three dimensional structure.
<i>Surface Preparation</i>	Physical and/or chemical preparation of an <i>Adherend</i> (<i>q.v.</i>) to make it suitable for adhesive bonding.
<i>Tack</i>	The stickiness of a <i>Prepreg</i> (<i>q.v.</i>).
<i>Template</i>	A pattern used as a guide for cutting and laying plies.
<i>Thermoplastic</i>	Capable of being repeatedly softened by an increase of temperature and hardened by an increase in temperature. Applicable to those materials whose change upon heating is substantially physical rather than chemical and that in the softened stage can be shaped by flow into articles by moulding or extrusion.
<i>Thermoset</i>	A plastic that, when cured by application of heat or chemical means, changes into a substantially infusible and insoluble material.
<i>Thixotropy</i>	The ability of a material to resist internal shear and to cling to a vertical surface.
<i>Thread Count</i>	The number of yarns (threads) per inch in either the lengthwise (<i>Warp</i> (<i>q.v.</i>)) or crosswise (<i>Fill</i> or <i>Weft</i> (<i>q.v.</i>)) direction of woven fabrics.
<i>Tow</i>	An untwisted bundle of continuous filaments.
<i>Tracer</i>	A fibre/fibre, tow or yarn added to a <i>Prepreg</i> (<i>q.v.</i>) for verifying fibre/fibre alignment and, in the case of woven materials, for distinguishing <i>Warp</i> (<i>q.v.</i>) fibre/fibres from <i>Weft</i> (<i>q.v.</i>) fibre/fibres.
<i>Unbound</i>	An area within a bonded interface between two adherends in which the intended bonding action failed to take place, or where two layers of prepreg in a cured component do not adhere to each other. Also used to denote specific areas deliberately prevented from bonding in order to simulate a defective bond, such as in the generation of quality standards specimens.
<i>Unidirectional Fibres</i>	Fibre reinforcement arranged primarily in one direction to achieve maximum strength in that direction.

<i>Vacuum Bag Moulding</i>	A process in which a sheet of flexible transparent material plus bleeder cloth and release film are placed over the lay-up on the mould and sealed at the edges. A vacuum is applied between the sheet and the lay-up. The entrapped air is mechanically worked out of the lay-up and removed by the vacuum, and the part is cured with temperature, pressure, and time. Also called Bag Moulding.
<i>Vent</i>	A small hole or shallow channel in a mould that allows air or gas to exit as the moulding material enters.
<i>Vinylester</i>	A type of resin with water absorption resistance qualities between polyester and epoxy.
<i>Viscosity</i>	The tendency of a material to resist flow.
<i>Void Content</i>	Volume percentage of voids, usually less than 1% in a properly cured composite. The experimental determination is indirect, that is calculated from the measured density of a cured laminate and the "theoretical" density of the starting material.
<i>Voids</i>	Air or gas that has been trapped and cured into a laminate. Porosity is an aggregation of microvoids. Voids are essentially incapable of transmitting structural stresses or nonradiative energy fields.
<i>Volatiles</i>	Materials, such as water and alcohol, in a sizing or a resin Formulation, that are capable of being driven off as a vapour at room temperature or at a slightly elevated temperature.
<i>Warp</i>	The yarn running lengthwise in a woven fabric. A group of yarns in long lengths and approximately parallel. A change in dimension of a cured laminate from its original moulded shape.
<i>Water Jet</i>	Water emitted from a nozzle under high pressure (70 to 410 MPa or 10 to 60 ksi or higher). Useful for cutting organic composites.
<i>Weathering</i>	Exposure of plastics to the outdoor environment.
<i>Weave</i>	The particular manner in which a fabric is formed by interlacing yarns. Usually assigned a style number.
<i>Weft</i>	Yarn oriented at right angles to the warp in a woven fabric.
<i>Wet Lay-up</i>	A method of making a reinforced product by applying the resin system as a liquid when the reinforcement is put in place.
<i>Wet Out</i>	The condition of an impregnated roving or yarn in which substantially all voids between the sized strands and filaments are filled with resin.
<i>Wicking</i>	The process of moisture up the reinforcing fibres in frp vessels.
<i>Working Life</i>	A surface imperfection in laminated plastics that has the appearance of a crease or fold in one or more outer sheets of the paper, fabric or other base, which has been pressed in. Also occurs in vacuum bag moulding when the bag is improperly placed, causing a crease.

<i>Woven Rovings</i>	Woven rovings take the form of cylindrical packages of several strands of equal diameter untwisted fibres loosely gathered into bundles where the fibres have diameters from 13 to 24 μm . See <i>Rovings</i> .
<i>X-Axis</i>	In composite laminates, the Longitudinal axis in the plane of the laminate.
<i>Yarn</i>	An assemblage of twisted filaments, fibre/fibres, or strands, either natural or manufactured, to form a continuous length that is suitable for use in weaving or interweaving into textile materials.
<i>Y-Axis</i>	In composite laminates, the axis in the plane of the laminate that is perpendicular to the <i>X-Axis</i> .
<i>Z-Axis</i>	In composite laminates, the reference axis normal to the plane of the laminate.
<i>Zero Bleed</i>	A laminate fabrication procedure that does not allow loss of resin during cure. Also describes prepreg made with the amount of resin desired in the final part, such that no resin has to be removed during cure.

